Request for an exempted fishing permit (EFP) to continue work with the Bering Sea pollock fishery to increase Chinook salmon escapement rates with improved salmon excluders

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Motivation: The case for additional work on a salmon excluder for the Bering Sea pollock fishery

Looking at Chinook (*Oncorhynchus tshawytscha*) bycatch data for the previous five Bering Sea winter/spring seasons (January through April, AKA the pollock “A” season) one can see that Chinook salmon bycatch rates have been increasing (see figure below).

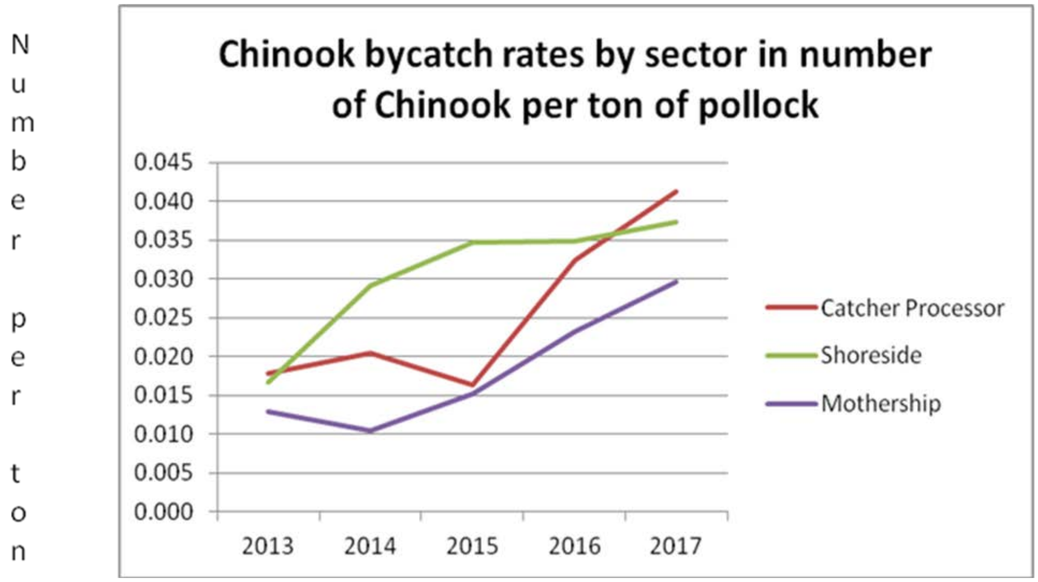


Fig 1. Bering Sea "A" season Chinook bycatch rates (number per metric ton of pollock) for catcher-processor, catcher vessels delivering to motherships, and catcher vessels delivering shoreside 2013-2017.

At a recent salmon excluder workshop in May 2017 in Seattle, WA organized by investigators on this proposal, many Bering Sea pollock captains indicated that they think the upward trend in Chinook bycatch rates is driven by a steady increase in Chinook salmon abundance. They attribute this to improved ocean conditions for stocks that inhabit the Bering Sea in their sub-adult phase. Increasing abundance has captains concerned that existing tools such as data sharing for hotspot avoidance, rolling closures, and salmon excluders may not be sufficient to allow the industry to harvest its pollock under bycatch control measures in place under Amendment 91. This concern is further fueled by the fact that a few pollock vessels in the fleet have reportedly already come close to their vessel-specific bycatch allowances during this past A season, completed in April. Others are concerned they will not be able to stay under their Chinook allowances for 2017 despite all their efforts to avoid catching Chinook salmon.

To fully understand the unease pollock captains have for the downstream effects of what appears to be increasing Chinook abundance, it is important to consider how salmon bycatch management measures affect the pollock fishery. Because the principle approach of controlling bycatch is to move away from bycatch hotspots, pollock fishermen believe they will be spending more and more time/resources moving away from salmon. This is problematic because areas of relatively high salmon abundance can be the same areas with otherwise good pollock fishing and/or high-valued roe bearing pollock. This tends to defeat the main intent of the American Fisheries Act, which is to create an increase in economic value by giving fishermen the ability to go fishing when/where it makes economic sense. This challenge is magnified by the relatively weak prices for pollock over the last few years. In this setting, fuel is one of the principle costs affecting vessel profit margins, especially for catcher vessels. To help preserve the bottom line, pollock captains are eager to avoid the costs of unnecessarily relocating the vessel to avoid salmon bycatch.

A more effective salmon excluder could therefore help mitigate the consequences of increasing salmon abundance for the pollock fishery by keeping rates low enough in some areas where salmon bycatch rates would otherwise be too high for a vessel to continue fishing. Based on results from the last two salmon excluder EFP tests conducted by North Pacific Fisheries Research Foundation (NPFRF), Bering Sea salmon excluders are not performing with the same consistency and efficacy as those in the Gulf of Alaska (GOA) pollock fishery. Specifically, in the 2013-2014 NPFRF testing the central Gulf of Alaska, escapement of up to 35%-55% for Chinook was achieved with the most promising result in the fall of 2014 with mean escapement at close to 55%. By contrast, the 2015-2016 NPFRF EFP in the Bering Sea showed much lower salmon escapement rates for the three size classes of vessels participating in the study (see Figure 2 below). Bering Sea A season results (where Chinook escapement is the main salmon species taken as bycatch) ranging from of 7-18%. Figure 2 shows that even the upper end of the range of escapement rates for Bering Sea boats are still well under mean escapement rates achieved in the GOA. As illustrated, not only are mean rates of escapement lower, but variability associated with Bering Sea trials is higher.

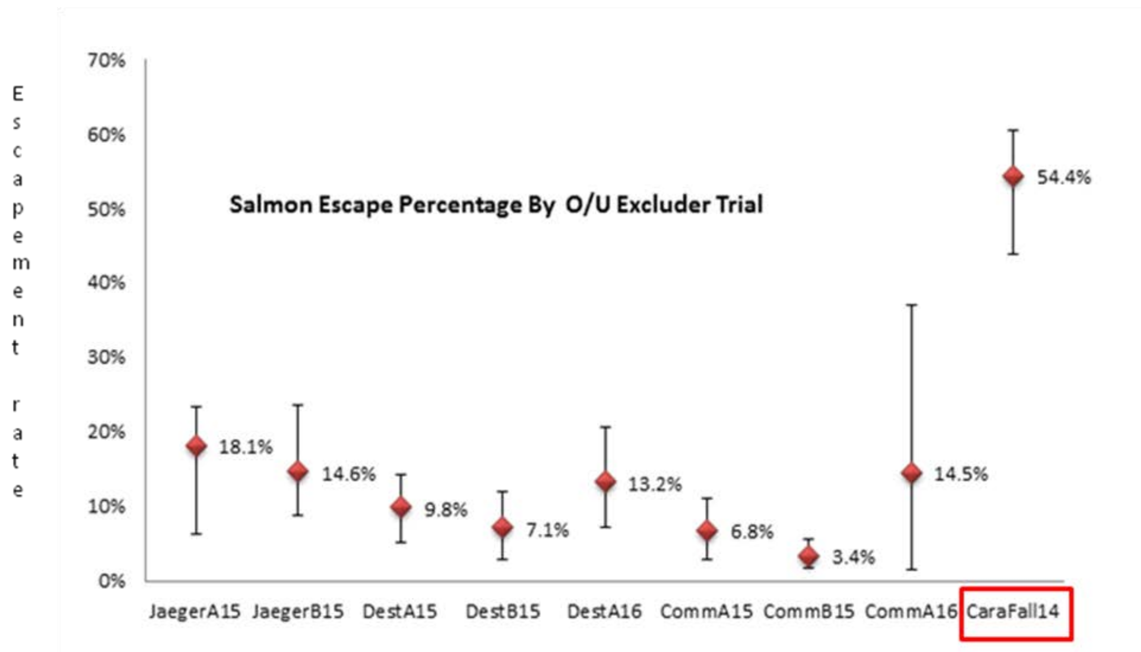


Figure 2 Percent of salmon that escaped during EFP trials, listed by vessel, year (2014, 2015, 2016), and season (A and B). Vessels conducting trials in the Bering Sea include the C/P *Northern Jaeger* ("Jaeger"), C/V *Destination*, and C/V *Commodore*. The result shown in the figure from the GOA (outlined in red) occurred in the fall of 2014 aboard the C/V *Caravelle*. Note that Chinook is the principle bycatch species year round in the Gulf of Alaska pollock fishery. Confidence intervals in the figure (α= 0.05) illustrate between-tow variability in escapement rates.

In considering escapement rate differences between the GOA and Bering Sea, it is worthwhile noting that the trials were conducted employing the same excluder design (the "over and under" excluder) and the same testing methods. While the same excluder was used in both the Gulf of Alaska and Bering Sea, the excluder was "scaled up" to be of appropriate size for the larger size/horsepower of Bering Sea pollock vessels. Previous trials have not always allowed for direct comparisons of the same excluder/testing methods. For this reason, results shown are a very useful for comparison. Also of note was that the GOA tests showed more consistent escapement rates on a tow by tow basis, hence relatively narrower confidence intervals. NPFRF feels that lower variability in escapement rates is an important indicator of effectiveness because it gives fishermen more confidence that the excluder will reliably exclude salmon, which affects the captain's decision making process for consideration of whether he needs to move the vessel to an alternative fishing location.

The topic of the status of excluders in the face of increasing Chinook abundance was discussed at the aforementioned salmon excluder workshop. The purpose of the workshop was to better understand what fishermen have been doing to adapt and improve excluders in the Bering Sea pollock fishery since the last Bering Sea EFP and to solicit ideas for further improvements. The workshop generated a high turnout among leaders in the fishing, scientific, and technology development communities, leading to a great deal of information exchange, feedback, and new ideas. A detailed summary of the May 2017 salmon excluder workshop is attached to this application.

One of the main 'take-home' messages from the excluder workshop was that fishermen and gear manufacturers have ideas for improvements to existing excluders, and are interested in doing more work to improve escapement (including additional efforts with lighting systems). It was clear from the workshop that there are new, innovative ideas for approaching salmon excluder development. Most importantly, attendees expressed a strong interest in new efforts to improve excluders, and believe that better salmon escapement rates are attainable through the use of excluders. Most workshop attendees agreed that systematic testing of excluders (both through individual sector efforts and NPFRF's efforts across all sectors) and technical support with video equipment/review of video footage have been critical to the progress made on excluder design and use. They also expressed the opinion that systematic testing often cannot be achieved well on vessels involved in the regular pollock fishery due to inability to slow down and do systematic testing.

This need for systematic gear trials is the primary motivation for using an EFP as the vehicle for further excluder development and field testing. An EFP field test is not as constrained by the economic operating margins of the regular fishery where slowing down costs the boat money. Participating vessels can focus more on testing according to the prescribed protocol. Although this slows them down, they get to, in exchange, catch additional groundfish to defray the costs of participation. Another advantage to testing with an EFP is that there is an upfront commitment to fishing systematically and to following the testing protocol with oversight to ensure it occurs. In the regular fishery, captains often change the rigging or other aspects of the excluder on a tow by tow basis based on what they see on that haul. Setting up the experiment under an EFP allows for more rigorous scientific design.

An additional benefit of the EFP for this research is that participants are provided exemptions to fish in areas of higher abundance of salmon than would otherwise be possible under Amendment 91 bycatch controls. Based on past experience, this appears to increase the chance that excluder performance can be determined in a statistically valid manner within a reasonably short duration of time devoted to field testing. The separate allowance for salmon under the EFP allows for increased power (i.e., higher and more consistent encounters with salmon per tow hence better sample sizes) to detect statistically significant differences.

For all of the reasons indicated above, Bering Sea pollock fishermen are interested in being directly involved with and carrying out further research to improve salmon excluders to reduce Chinook bycatch under an EFP. They recognize that this is a necessary step in generating the data necessary for furthering the development of salmon excluders. At the excluder workshop, many expressed the view that NPFRF's previous EFP work has been instrumental to the industry's ability to improve the performance of salmon excluders in the past, and that further EFP research is needed to continue along that path towards reliable and effective excluders.

<u>EFP objectives and plan for achieving them</u>:

Our previous EFP work has shown that excluder performance variability in the Bering Seas is strongly linked to the size/horsepower of the vessels. Recognizing this important covariate, <u>the goal of this EFP is to work with fishermen from the different horsepower/size classes of the Bering Sea pollock fishery to identify which excluder design(s) and what specific rigging applied to them are most likely to produce the greatest relative improvements in terms of reductions in Chinook bycatch rates</u>. Excluder designs and rigging configurations identified by fishermen as "promising" will be tested systematically in field tests under conditions that approximate as closely as possible actual commercial fishing practices in the Bering Sea pollock fishery. This will be done in 2018, 2019, and 2020, with results from each year guiding the design, for each vessel size class, to be tested the subsequent year. The field testing will provide data and information to evaluate the performance of each excluder/ rigging combination. These data will be disseminated to the fishery through follow up workshops after each field season of the EFP. Ideas for improvements from the subsequent workshops based on what was learned from the data and fish behavior video will be used through an interactive process of field trails and workshops to make consensus-based changes in the excluder design and rigging to be tested in the following field seasons. This process will be followed to hopefully achieve significant improvements to excluder performance for each specific size classes for the Bering Sea pollock fishery.

Specific steps to attain objectives are as follows:

1) Prior to first field testing in late winter of 2018, we will organize meetings with captains and other representatives of each vessel size class in the Bering Sea pollock fishery (small catcher vessels, CV, = <1,800 HP, large CV =>1,800 HP, and catcher processors, CP). These meetings will be used to generate a short list of the most promising ideas for improvements to existing excluders or new designs for each vessel size class grouping. Discussions with meeting attendees will result in the selection of the highest priority excluder design/rigging combination to be field tested in the EFP the first field season. A trip to the flume tank in St. Johns Newfoundland to look at models of designs of interest and a Cooperative Research Workshop in the fall of 2017 will also provide additional

venues for discussions of excluder designs to prioritize for the first season of field testing.

2) We will conduct three field seasons of testing for each excluder set up and vessel size class using methods described below. The first season will start with the most promising idea and the agreed upon excluder rigging set-up (e.g., how much weighting on the excluder panels and/or how much artificial light). The second and third field seasons will test adjustments to the initial device/set up based on what was learned in the initial field tests.

3) We will analyze data from each field test at the completion of each field testing season, and will present findings to the pollock fishing industry and interested public as soon as the results are available. Through improved data collection and analysis described below, we expect this study to be more definitive as to the factors affecting performance than in previous EFP research.

4) We will draft a final report to convey our methods and results which will include a description of our process to determine which excluder designs/rigging to test and each iterative change based on what was learned in the field testing stages of the EFP. The analysis will include an improved data analysis described below where we anticipate being able for the first time to evaluate escapement with respect to what was going on in the net and with the vessel speed etc. at the specific time of the escapement occurred. We expect this to result in a much-improved analysis of how covariates affect performance than was possible in the past with "averaged" vessel speed, groundfish catch rates, and other data for analysis of covariates in our past EFPs. The end result should be a more definitive assessment of factors affecting escapement which is turn should help to better inform which excluder designs and fishing practices are most important for improving excluder performance in the future.

Table 1 below illustrates the major steps and milestones that will be undertaken to accomplish the objectives of this EFP

Activity	Nov-Dec 2017	Jan-Mar2018	May-Sept 2018	Nov-Dec 2018	Jan-Mar2019	May-Sept 2019	Nov-Dec 2019	Jan-Mar2020	May-Dec 2020
Meetings to discuss most promising excluder options per vessel class	x								
Flume tank trip to develop excluder designs of interest from meetings	x								
AFSC Cooperative Research workshop	x								
Construction/rigging of excluders for testing		x							
NMFS panel selects the 3 vessels for the 3 seasons of field testing		x							
First season of field testing		x							
Video review and data analysis			x						
2nd meetings with CP, LCV, SCV to discuss results, prioritize changes				x					
Construction/adjustment of excluders for 2nd field season					x				
2nd field testing season					x				
Video review and data analysis						x			
3rd meetings with CP, LCV, SCV to discuss results, prioritize changes							x		
Construction/adjustment of excluders for 3rd field season							x		
3rd field testing season								x	
Video review and data analysis									x
Final meetings with CP, LCV, SCV to discuss results									x

Testing Methods

Overview:

When considering the methods described below, we think it's important to keep in mind that cooperative research with the pollock industry on a salmon excluder straddles the line between science and an iterative process that needs to engage and retain the commitment of fishermen whose knowledge is critical to the eventual success of the excluder designs. Fishermen depend on excluders to help them avoid the consequences of catching too many Chinook salmon under the cap and rolling closure program. So the incentives for fishermen to want to participate are clear. At the same time, from a scientific perspective we know that seasonal and year-to year variability, vessel size/horsepower, and other vessel and net-specific factors affect excluder performance. From a pure science perspective, therefore, we would want to hold an excluder design/rigging constant for testing across vessel size classes for several fishing seasons. This would hopefully control for sources of variability affecting excluder performance independent of the excluder design itself. The problem with that approach in our context, however, is that under some scenarios doing so would likely diminish the buy-in from fishermen to the point where there might be not be much willingness to devote the time and energy to develop ideas through the process outlined above to improve/perfect those designs.

In the extreme we know from our experience that fishermen will not be willing to collaborate in a process involving multiple tests of the same exact excluder that does not perform well in the initial trial. This stems from the practical perspective that an effective excluder would be highly likely to show some promising selectivity in the initial trial and if it does not show much promise right out of the blocks it probably never will be a workable design. In our experience, however, fishermen are reasonably willing to do repeated trials on an excluder works the first time. At that point it seems they will invest the time because they want to see if performance will hold up over different seasonal fishing conditions so they can rely on that in the fishing decisions they make.

This background is offered to assist with the collective understanding of the testing methods described herein noting that we have used the same approaches over multiple EFP projects and we have had considerable success determining excluder performance and retaining a good cooperative working relationship with fishermen over time. For this reason, this EFP also employs a "progression" approach wherein an agreed upon starting point for an excluder design/rigging is determined from feedback from the meetings with fishermen in each vessel size class. Adjustments to that initial starting point are made based on performance data. If the initial trials show little promise then the second round of testing will start with a new design. This iterative process has been used in all of our salmon excluder trials since 2006 and the progression process is more formalized in this EFP than before based on feedback from the recent salmon excluder workshop mentioned above.

After the initial trials, consensus modifications will be made based on the data and experience from the field trial. In this regard we expect the performance data this time to be more useful than our interim analyses in the past reflecting the improvements in our methods to assess performance through the use of "real time" information about what was occurring at the time of escapements, near escapements, or lack of escapement in the net and with the vessel towing the net. Additionally, we expect that the cameras collecting data on fish behavior will once again provide useful information to fishermen about how fish behave as the attempt to escape. This is obviously a supplement to the escapement performance data for fishermen to think about how to modify the excluder and its rigging to make it work better in this progression. Overall, this collaborative and iterative approach has worked in past to allow for an assessment of excluder performance with useful confidence intervals on salmon escapement rates. It has also achieved solid buy-in from industry and we expect that the improvements we are making to process in this EFP will increase that success.

In summary, we think it is important to make clear that we recognize the potential scientific value of holding factors constant in repeated scientific trials to account for the potential effects of seasonal variability in the conditions affecting salmon abundance and therefore salmon excluder performance. Our testing methods attempt to incorporate as much standardization and control to account for seasonal variability and other sources of inherent variance. To help control factors to the extent possible, we will keep the same test vessels, same trawl doors and nets (the net itself not the excluder), the same codends, towing speeds, and other factors in our control as constant as possible over each of the three testing seasons.

At the same time, to rigorously look at how seasonal variability affects excluder performance from a scientific perspective would potentially mean keeping the same exact excluder and rigging over several seasons even if that excluder did not work in the first season. This would be fine with fishermen under the scenario where performance in the initial trial achieve reasonable selectivity. In fact, encountering that very situation in its initial testing of an over and under design excluder in NPFRF's excluder trials in the Gulf of Alaska EFP in 2013-2014, we had full support of our industry collaborators for holding that excluder constant over repeated trials because there was considerable interest in knowing whether the 35-50% rate the escapement was a fluke or not (it was not). But in the case where the starting point for the excluder proves not to be an improvement over current Bering Sea designs (or it underperforms the current designs), we will not make multiple trials of an excluder/rigging configuration.

For additional context, it is important to point out that fishermen in their *ad hoc* trials would and typically do make changes to the excluder they are working on (outside an EFP) after as little as one or two tows. This is done when they see things aren't working from the number of salmon they are catching or some relatively small amount of video data they have collected. So in reality, getting fishermen to hold the excluder and rigging constant for one complete seasonal trial in the context of this EFP is already seen as an accommodation for the purposes of systematic testing by fishermen. We know from experience that fishermen are willing and committed to doing this and understand its importance.

With the background above, we also recognize that a great deal of specific detail on methods for determining escapement rates for pollock and salmon in our EFPs is already written up in the final report for EFP 15-01. That material covers in detail how different excluders were tested, how testing protocols were designed and followed, how vessels were selected to participate in the EFP, etc. Given this, we focus here on providing explanations where we are proposing to make small modifications to the methods from EFP 15-01 based on the recommendations from the final report for that EFP and other lessons learned/new ideas/improvements in equipment since that EFP.

Improvements for collecting data to determine salmon and pollock escapement rates: The general approach to tracking escapement relies on underwater recording video cameras deployed in nets by field project managers. NPFRF's work on field testing excluders started with recapture nets more than a decade ago, but concerns from pollock fishermen that recapture nets affect escapement rates led to the use of underwater camera systems to track escapement. This also became more possible with improved capabilities of video systems that can be deployed on fishing nets in recent years.

For the proposed EFP research, the camera installations will be where we can best collect definitive data on escapement. We are prioritizing this because at times in the past it has been difficult to know for sure whether salmon moving towards the escape hole have actually left the net, due mainly to limitations in the distance cameras can record with sufficiently clear visibility to determine whether fish are actually outside the net. To collect information on fish behavior and shape of the excluder and net near the escapement portal(s) we will rely on different cameras installed expressly for that purpose.

Information on success rate with the camera system used in the last Bering Sea EFP is reported on page 15 of the final report for that project (Table 2), which we have excerpted below. "Success" in this context is the proportion of tows where the video camera(s) collected data sufficiently to determine salmon escapements throughout the entire duration of the haul. The success rate ranged from 85% -100% of the EFP tows by testing season and participating EFP vessel. The overall success rate for all vessels and testing seasons was 95% based on the overall number of tows for EFP 10-01. This relatively high rate of success was due to NPFRF's use of two cameras at each escapement portal which was expensive in terms of equipment and video review costs but rather worthwhile as it turned out because the "redundant" camera covered for most of the times when the main camera failed. While a fairly high overall success rate, in the worst vessel-specific case at least we had a failure rate of 15% and this required us to drop several of the EFP tows from the analysis.

Percentage of EFP tows with complete video per vessel per testing season

	A 2015	**B 2015**	**A 2016**
CV Commodore	**100%**	**95%**	**95%**
CV Destination	**90%**	**96%**	**85%**
CP N. Jaeger	**97%**	**96%**	**100%**

Table 2. Camera performance assessment over the seasonal testing (A and B seasons) for vessels that participated in EFP 15-01.

With the goal of improving camera system performance for this proposed EFP research, NPFRF has been working since the last EFP with a deep-sea video/monitoring equipment company called Williamson and Associates located in Ballard, WA. This company has significant experience with collection of video at depths far greater than those fished in the pollock fishery. With Williamson and Associates we have recently completed this *Beta*-testing a new design of underwater camera system. Trials show that the new cameras will significantly reduce the issues experienced during research from the past two EFPs. The new systems are fully contained inside a 3 inch diameter tubular aluminum case (hence referred to as “tube cameras”).

These “tube- style” cameras have a viewing portal that allows the camera lens to collect video through the center of the tube. From our experience this is preferred for both tracking fish escapement and looking at fish behavior in pollock nets due to ease of installation in the net and efficiency of aiming at the desired area of the net. This style of camera also largely avoids the often-encountered problem of fish becoming pinned on a flat surface thereby blocking the view.

Tube cameras were used in the previous two EFPs. These first generation cameras have since been improved. The new camera systems (the *Beta* version of our new camera is seen in the figure below) have a sapphire crystal portal in the middle of the strong metal housings, a major upgrade in strength and resilience. Battery capacity to power the lights, camera, and recorder has been upgraded to approximately 12 hours of continuous operation on a reliable basis (compared to typically less than eight hours with the former systems). This aligns better with towing times under realistic fishing conditions, especially in summer when tow duration is longer (up to 8 hours per tow is not uncommon). In addition to the gains in durability and battery capacity, the most important upgrade with these systems is that data downloads and charging are done through an external USB port. In the past, downloads and charging required the camera tube be opened each time. While faster in terms of turn-around, the need to open the cameras for each recharge/data download led to failures of the seals to seat correctly at times thus leading to flooding and system failures.

Fig 3 *Beta* version of the tube camera developed by Williamson and Associates that will be used to quantify salmon and pollock escapement in the proposed EFP research.

Data collection methods for this EFP will reflect lessons learned during previous EFP studies. Specifically, all video data will have a synchronous time stamp so that escapement events can be tracked with other potentially useful data collected simultaneously. The additional data collected along with the video of escapements will include instantaneous vessel speed, relative volume of fish flowing through the net where the excluder is installed, shape of the net where the excluder is installed, and other information that we think could be important for understanding how, when, and hopefully "why" excluders work or fail to do so.

Following each EFP season, our field technicians will review the video and count salmon and pollock escapement. For pollock, the average length of the fish in the codend will be converted to estimate weight of pollock loss. We feel comfortable with this approach because, during our earlier testing that relied on recapture nets, size distribution of escaping pollock closely mirrored that of retained pollock. Salmon escapement will continue to be monitored and accounted for by number, but not species because species cannot always be determined from underwater video. As was done in the past, escapement rate analysis will assume that the predominant species of escapement will be Chinook during the A season fishing because winter/spring is when Chinook is the predominant species of salmon bycatch in the Bering Sea pollock fishery. Further, the fraction of retained Chinook versus non-Chinook salmon species in the codend will also be calculated per field test to help ensure this assumption about seasonality of salmon bycatch species remains accurate.

In reviewing the video footage, NPFRF's field project managers will write down the time corresponding to escapements from the time indicator that is stamped to the video. Times of near escapements and other "events of interest" such as salmon moving back through the net with no apparent notice of/effort to use the excluder will also be recorded during the video review process. Having these events in a time-referenced format will allow us to evaluate them in the context of what was going on relative to fishing conditions. The intent here is to use these "auxiliary" data to enhance our understanding of what results in escapements and what does not. These covariate data will include, relative volume of fish moving through the excluder section at a specific time, time-referenced speed over ground for the vessel, shape of the excluder over time during each tow, fishing depth over time, sea state, and time of day.

We anticipate that inclusion of covariate data into the analysis will not only greatly enrich our understanding of factors that affect escapement, but will also increase our power to detect significant relationships between the covariates and escapement. At this time we anticipate using binary logistic regression to evaluate covariates but we will be working with our collaborator from the Alaska Fishery Science Center's RACE Division (Dr. Noelle Yochum) to refine approaches to the covariate analysis once we have some data from the initial field season. The importance of the covariates was discussed in detail in the final report for the 2015-2016 EFP (see EFP 15-01) and these additions to data collection and the analysis are in response to what was learned from the findings of EFP 15-01. For example, these additional data will allow us to evaluate the way pollock catch rates affect salmon (and pollock) escapement rates. Without having data to track instantaneous catch rates, our analysis had to rely on average pollock catch rates (total catch divided by towing hours). This may well have affected our ability to evaluate the linkage between pollock catch rates and salmon escapement in previous EFP studies because inherently instantaneous amount of fish at the time a salmon passes through the section of the net with the excluder seems more likely to affect escapement than average rate.

Test fishing sample size to afford a reasonably high chance of detecting significant differences and having sufficiently representative results:

At the start of NPFRF's work on salmon excluders more than ten years ago, power analyses were developed to help evaluate target sample sizes for evaluating the effect of the excluder in the context of inherent seasonal and spatial variability in salmon catch rates. The motivation for the earlier analyses was the inherent variability in salmon catch rates, which affected the desired amount of statistical precision selected for the test. While the power analysis from ten years ago was interesting, it was admittedly highly influenced by the proxy selected to represent the among-tow variability. Because there were no data available for the actual area/time where the experiment was going to take place, the power analysis relied heavily on experience from the areas/times open to fishing. Data from the areas open to fishing at that time (and today) reflect highly variable Chinook salmon bycatch rates, which resulted in a power analysis indicating that sample sizes needed to be very large to have any real chance of detecting significant differences.

From this starting point, we learned from EFP fieldwork that encounter rates and consistency of salmon encounters in the closed areas (rolling hotspots) were actually relatively more stable and predictable compared to the high variability outside the closures. This meant that variance associated with encounter rates inside the closures was relatively lower, helping to make differences in escapement rates attributable to the excluder easier to detect. This meant that testing with relatively smaller sample sizes could achieve useful confidence intervals around mean escapement rates.

From this observation NPFRF evolved to rely on an amount of test fishing (groundfish catch associated with a desired number of tows) that has in the past allowed for the analysis to generate useful confidence intervals around mean escapement rates for salmon. This approach has been successful not only in terms of generating statistically meaningful estimates of excluder performance, but also in terms of industry buy-in that the results are valid and representative of what could be expected from use of the excluder at least under similar fishing conditions to those occurring during the test.

For the aforementioned reasons, we are opting to base our target sample sizes on those which previously have allowed us to conduct statistically relevant analyses. We know that reasonable confidence intervals around mean escapement rates for salmon have been obtained from 10-12 tows per EFP vessel per season. Based on these numbers, we are requesting the same groundfish and salmon bycatch allowances (based solely on winter/spring or "A" season testing amounts within EFP 15-01) for this EFP. Our allowances are designed around A season catch expectations because this EFP is solely focused on Chinook salmon escapement and winter/spring or the pollock A season is predominantly when Chinook salmon are encountered in the Bering Sea pollock fishery.

Table 3 below details the catch allowances we are requesting for this EFP.

Year	EFP Testing Seaso	Groundfish allowance (MT	Chinook catch allowance (#)	Non-Chinook catch allowance (#)
2018	A season (1/20 - 6/10)	2,500	600	600
2019	A season (1/20 - 6/10)	2,500	600	600
2020	A season (1/20 - 6/10)	2,500	600	600

Table 3 Specific catch allowances of groundfish (metric tons), and Chinook and non-Chinook salmon (individuals) requested for this EFP by year and fishing season.

Given we are modeling our sample size on the last Bering Sea salmon excluder EFP (EFP 15-01), the amounts of groundfish and Chinook salmon are essentially the same as what was requested (and granted) for A season testing seasons within EFP 15-01. Note that EFP 15-01 had two field seasons during the A season focused on Chinook escapement and one field season focused on "non-Chinook" (chum salmon) escapement. The requested numbers of Chinook and non-Chinoook salmon for this EFP were therefore adjusted to reflect our sole focus on Chinook bycatch performance. For this EFP the requested numbers of Chinook are based on the numbers requested for the A season tests that were part of EFP 15-01. A buffered allowance of non-Chinook salmon is requested here to avoid problems we encountered in the 2015 EFP A season testing. Specifically, the requested number of chum salmon is designed to cover the minimal catches one would expect in A season except that we have buffered those numbers up to reflect the expectation that encounters of non-Chinook appear to be getting more common in the A season in recent years than in the past.

This was not anticipated in the application for EFP 15-01 the permit was issued based on what was requested. This unfortunately led to our first A season field tests in EFP 15-01 being terminated before the amount of testing that was slated to occur was accomplished. Following that, we requested a modification to the permit and granted but this consumed considerable Agency time and resources and we want to avoid a repeat of that here. To do so, we have simply requested the same number of chums per season as Chinook for each testing season of this EFP. We are confident under this plan that chum salmon catches will not constrain our testing for this EFP.

To ground truth the requested numbers of Chinook in the context of bycatch rates from the most recent A season pollock fishing (January –April 2017), which is one season more recent than the data we had from our A season 2016 encounter rates, we requested Sea State Inc. provide us with 2017 A season Chinook bycatch rate data from the regular Bering Sea pollock fishery. This is useful for evaluating our requested numbers of Chinook against the latest A season Chinook bycatch rates. There are lots of ways to look at bycatch rates in any pollock A season. In this case we relied on Sea State's experience with monitoring salmon bycatch in the fishery and simply asked them to come up with their best proxy for bycatch rates that would be most representative of what would be encountered inside the closure areas where we plan to do our testing. Sea State evaluates Chinook bycatch data from the pollock fishery to trigger the temporary "hot spot" rolling closures and because some or all of our EFP testing will be inside those areas it makes sense to use data from the tows that effectively set up those closures.

To reply to our data request, Sea State relied on average bycatch rates (number of Chinook per metric ton of pollock) from the set of tows that accounted for 25% and 50% (respectively) of overall bycatch of Chinook in numbers for the 2017 pollock A season. Accordingly these were:

25% of bycatch in top 113 hauls, or 3.8% of tows, average rate = 0.239 Chinook per ton of Pollock
50% of bycatch in top 372 hauls, or 12.3% of hauls, average rate = 0.146 Chinook per ton of Pollock

Using these rates as the best available proxy for what would be expected to be encountered inside the closed areas we then "back calculated" what our numbers of bycatch Chinooks taken in the EFP would be if we do all of the EFP fishing for the requested allowance of groundfish inside the closed areas and the average rates above were applicable to our EFP testing. Accordingly, using the Sea State's rate from the tows that accounted for 25% of the overall number of bycaught Chinook in the pollock fishery in A season 2017, the average bycatch rate was 0.24 Chinook per ton of Pollock and multiplying that rate times 2,500 mt of groundfish (per testing season) we therefore derive an estimate of 597 Chinook caught per testing season.

In this light, our requested number for this EFP based on mirroring what was requested in 2015-2016 EFP is 600 Chinook (to be shared among the three vessel classes). Based on this our requested number seems to measure up fairly well. We note here that the use of "average" rates for the small number of tows accounting for 25% of the A season bycatch in 2017 is somewhat of a dart throwing exercise. This is because the very small number of tows in the EFP could still have higher (or lower) than average rates relative to our expectation what will be present in the closed areas when we dod the testing in 2018-2020. At the same time, our expectation is that the excluder tested will be of a design that outperforms the ones used in the fishery on average. Salmon that escape during the EFP are not counted towards the limit applied to the EFP catch allowance. The fishery data from the high bycatch rate tows used by Sea State does reflect excluder use but the excluder in use for the EFP boats should be expected to outperform the fishery on average so this should create a little more of a buffer to help ensure that EFP catches stay below the 600 per season limit. In fact the allowance requested in the application for EFP 2015 used similar data to come up with a requested number of Chinook. The 600 Chinook limit each A season for the 2015-2016 was actually not taken. The total number of Chinook that did not escape (recovered in the codends from EFP tows) was 439 in 2015 and 352 in 2016).

<u>Testing protocol</u>: To make the EFP results meaningful, the rigorous methods used in previous EFP research will be followed. These include: ensuring that the excluder is not changed during the course of any of the seasonal tests; if the excluder becomes damaged then restoring it to the original shape and rigging, maintaining towing speed and other fishing variables as constant as possible while catching commercially representative amounts of fish per haul etc. The EFP testing protocol has been used over several EFPs

and it has proven to be practical for all the vessels selected by AFSC's selection panel over all our fieldwork.

To ensure the protocol is followed and that the test tows are standardized, prior to the test, participating vessels will make a series of pre-test tows to establish that the excluder and net are achieving the intended shape, and that lights etc. are functioning as designed. The codend will be closed for these hauls to ensure water flow reflects what will occur in the actual testing; however, the pre-test tows will be completed in areas without fish so that allotted groundfish and salmon are not expended at this point. If any problems are detected with the shape or rigging, these will be resolved and additional pre-test verification tows will be done to ensure everything is as intended prior to commencing the official test tows.

During the application process, applicants must agree to commit to follow the EFP testing protocol if selected to participate in the EFP. One of the biggest challenges in preparing their applications is that captains must explain how he will accommodate the placement of cameras into their fishing activities as part of the testing protocol. In our experience, the installation of cameras greatly affects how fast the net can be set, and, therefore, the degree to which the net actually be set in a manner that will allow it to encounter the school of pollock that that is targeted. The issue here is that the delay to install cameras, no matter how efficient the project manager and crew are at this task, reduces the chances that the captain can get the net set on the specific fish marked on his sonar instruments when he selected the specific location for a haul. To limit this interference in timing, camera installations are done in pre-designated and marked locations in the net. This can nevertheless add up to delays of 20 minutes per tow, especially when the weather complicates camera installation and deployment.

In their application participating vessels will also be required to describe how they plan to fish while still allowing us to collect all the EFP data during the test. This includes their strategy for how to maintain pollock catch rates that are representative of normal fishing conditions while taking steps to stay in areas with above average salmon bycatch rates, etc. This latter requirement will be the most demanding given that it often requires a lot planning to come up with a fishing location that meets this standard of having representative pollock catch rates and above-average salmon bycatch potential. In the past, EFP vessels have shared salmon bycatch and pollock catch rate information whenever concurrent testing occurs. Sharing information is important because when testing occurs in the closed areas there are no other sources of catch information available. Sharing information saves all parties fuel and time because they are the only vessels operating inside the closures whenever EFP testing occurs inside the rolling hotspots.

Once the vessel works out the specifics of how it will fish according to the standardized plan, during the test the project manager will monitor operations to confirm that the vessel continues to fish as closely as possible to what it outlined for the testing and will be tasked with ensuring that tows are completed as systematically as possible. This entails maintaining the same towing speed and other aspects of fishing, maintaining the way the excluder is rigged in the net and the lighting equipment, making sure the flotation, weighting and other aspects of the rigging of the excluder remains as constant as possible throughout the EFP testing for that season. If for some reason a large amount of catch occurs or fish become pinned in the net in a manner that affects the excluder, time must be taken to restore the excluder to the original state. Spare webbing and materials will be brought out for the EPF testing to ensure this can occur.

In order to ensure that the EFP testing is encountering sufficient levels of salmon to meet the objectives of the test, steps will be taken to get an index of how many salmon the testing is encountering in near real time during the test. This is done by examining the number of salmon in the codend as the codend is dumped for catcher vessels and looking at the salmon collected for donation in the factory as soon as the contents of a haul is run over the flow scale and sorted for CP vessels. Tracking salmon encounter rates in real time helps ensure that the test tows are actually encountering sufficient numbers of salmon to meet the objectives of the study. This is necessary because, even when testing occurs inside the closed areas, salmon encounters cannot be assumed to occur and rates can still be low inside the closed areas at times. If the number of encounters is low relative to expectations, the test vessel will be informed that it needs to shift EFP fishing to another part of the closed area or other area where the target conditions (at least average pollock fishing conditions and above-average numbers of salmon) can be found.

For catcher vessels, a single seasonal test typically spans two to three back to back fishing trips with three to five tows per trip on average. For catcher-processor vessels the EFP catch allowance is typically a portion of a single trip. In recent EFPs, NMFS has allowed CP vessels to catch EFP fish and non-EFP fish on the same trip. This allows CP vessels to incorporate the EFP fishing into one of its regular trips. This accommodation is important to CP participants because it avoids the need to offload all non-EFP products before commencing an EFP trip or vice versa. This saves fuel and time associated with a port call and offload when the boat is not at frozen product hold capacity. The allowance for mixing EFP and AFA fish on the same trip is limited to CP vessels because the official accounting of CP catches is done at-sea for catcher processor vessels via their certified and inspected flow scale and other catch accounting and reporting facilities on board. For purposes of proper accounting, normal AFA fishing and EFP fishing cannot occur on the same day.

From the perspective of the objectives, the allowance to do EFP and AFA fishing on the same trip is beneficial because, with the proper commitment from the vessel to follow the testing protocol for an entire trip, the EFP is able to increase sample size without increasing the amount of pollock and groundfish requested in the EFP application. As was mentioned above, there are advantages to expanding sample size even if the amount of fishing from the EFP allowances alone is expected to be sufficient for statistically valid results. The testing done on CP vessels while they are using their own allocation of fish is typically not as likely to be useful for deriving statistically robust results simply because during the portion of the trip where the vessel is using its own fish and salmon allowances they are not able to operative inside the bycatch hotspot closed areas and typically they operate in areas with far lower encounter rates for Chinook salmon. At times lower but non-zero catch rates of Chinooks have occurred while the vessel is using its own fish so there is value to this extra fishing. Additionally, the additional fishing in under regular fishing conditions does provide the captain with additional and valuable information about how the excluder works in terms of pollock escapement and other factors even if the encounter rate with Chinook salmon is likely to be far lower during that portion of the trip.

Process for selecting EFP vessels:

As part of its duties to conduct and manage the EFP, NPFRF sends out a request for proposals (RFP) to all Alaska pollock trade associations and cooperatives. The RFP informs vessel owners and captains of the opportunity to participate in the EFP research including a short description of the objectives and how the field testing fits into the overall development of excluders. The RFP also includes considerable detail on the testing protocol interested applicants must follow if selected to participate, the target catch allowances participating vessels can harvest assuming they successfully follow the protocols, a description of how participation in the testing has affected the catch rates of participating vessels in the past..The RFP also provides a template for applicants to follow for drafting their proposed fishing plan, essentially what they need to include to fully describe the facilities for testing on the proposed vessel and the experience of their crew with pollock fishing, salmon excluder usage and testing, and other experience with scientific charters and research. By and large the RFP is designed to be a template for how to apply to participate in the EFP. It also includes all logistical information, including deadlines and key metrics for how applications will be judged.

In addition to sending out the RFP, NPFRF will provide information about the EFP testing at the focal meetings with each vessel size class sector of the Bering Sea pollock fishery. At these meetings we will work with participants to select the salmon excluder/ rigging set ups that will be tested under the EFP. Information about the EFP will also be made available to attendees at a salmon excluder workshop at the flume tank at Memorial University (St. Johns, Newfoundland, Canada) in November 2017 (hosted by investigators of this proposal). Finally, Dr. Noelle Yochum our AFSC collaborator for this project is putting together a workshop on cooperative research slated to occur just after the flume tank trip in November. Many pollock fishermen are expected to attend the AFSC workshop and between that and the flume tank trip this EFP will have an above-average outreach where fishermen can learn about the EFP and the opportunity to participate.

Applications by vessel owners/captains will be reviewed first for completeness by NPFRF. The RFP specifically informs applicants that if submitted in advance of the deadline, they will be afforded an opportunity to address oversights/ missing information in their applications based NPFRF initial review of the application. Applicants will still have to meet the deadline if they elect to make amendments to their applications.

After the deadline, NPFRF will work with the director of the RACE Division of the Alaska Fishery Science Center, Jeff Napp, to review applications. Dr. Napp will assemble a review team comprised of RACE staff experienced in reviewing proposals and other submissions for engaging NMFS' charter vessels for the trawl survey and other NMFS charters. The review committee ranks the applications based on the criteria spelled out in the RFP. NMFS' assistance in the review and ranking of applications is instrumental in objectively selecting the best-qualified vessels for the field testing. This review process has worked well in the past due to the RACE Division's considerable experience with what makes vessels suited for doing scientific work. They also take into account what constitutes a safe platform for a unique approach to applied research spanning fishing and collection of scientific data.

Exemptions needed to pollock fishing regulations during 2018-2020 Pollock A seasons:

1. While conducting EFP testing under this permit, we request that the EFP vessel be exempted from the "Rolling Hot Spot" area closures (now promulgated under Amendment 91) so that the EFP field work can be conducted in the salmon bycatch hotspots areas as necessary.
2. While conducting EFP testing under this permit, we request that the EFP vessel be exempted from the regulations regarding fishing in the Sea Lion Conservation Area (SCA).
3. While conducting EFP testing under this permit, we request that the EFP vessel be exempted from regular observer coverage requirements for vessels when participating in our salmon excluder EFP field tests. We need to be able to place up to two sea samplers working directly for the principal investigator and field project manager on vessels participating in this EFP. Additionally, we need to redirect sampling to concentrate on effects of the excluder on salmon and pollock catches. This is the same exemption we have requested and been granted in the past salmon excluder EFP studies. Sea samplers will be provided all equipment needed to do their work and no NMFS-issued equipment will be used by sea samplers during data collection or other activities promulgated under this EFP.
4. While conducting EFP testing under this permit, we request that all groundfish and salmon catches not count against the regular groundfish TACs or any salmon bycatch caps affecting the regular pollock fishery or other in-season salmon bycatch control measures in place for the regular pollock fishery (e.g., bycatch avoidance agreements under Amendment 91).

Areas where EFP testing is expected to occur during 2018-2020 Pollock A seasons:

Predicting where adequate concentrations of salmon and pollock will occur from year to year is inherently difficult due to inter-annual variation in pollock distribution. For this reason, it is impossible to specify exactly where the EFP testing will occur over the three A seasons tests from 2018-2020. The figures below show areas where most pollock fishing typically occurs during A Season but these are fairly broad and, in reality, in any one year a great deal of the winter pollock harvest would be expected to occur in a small portion of one of more of these areas.

Figure 4: Common fishing areas around the Pribilof Islands

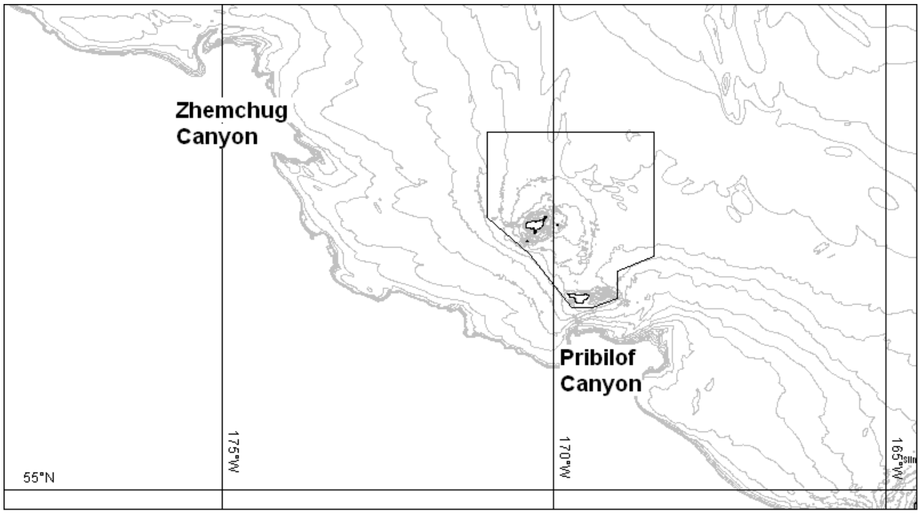
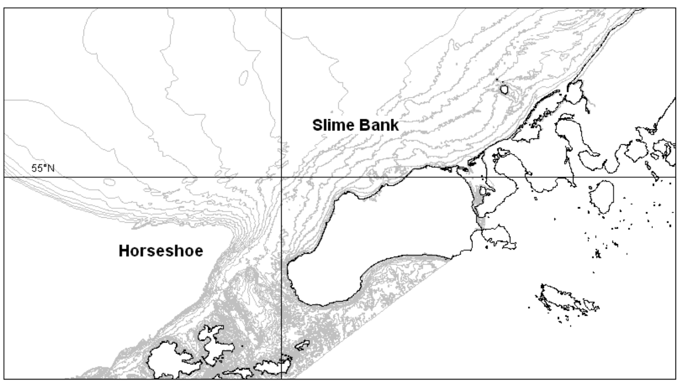


Figure 5: Common fishing areas around Unimak Pass and Bering Canyon (Horseshoe)



Administration of the EFP: Administration of the EFP will follow the same procedures used for the previous salmon excluder EFPs by the same EFP researchers. The exempted fishing permit holder (EFP applicant) will be responsible for the overall execution of the EFP research, including carrying out and overseeing all field research and associated responsibilities of the EFP. This includes hiring qualified personnel to manage the field experiments, and working with the NMFS-certified observer provider companies to ensure the experiments utilize qualified sea samplers. The permit holder will ensure that sea samplers are provided with instruction and briefing materials to understand their sampling duties for the EFP. Likewise, the EFP permit holder will prepare materials for and conduct the meetings with the different sectors of the pollock fishery to select the most promising ideas to test and subsequently to make adjustments based on information from each testing season. To engage vessels for the fieldwork, the permit holder will draft the RFP and the other explanatory materials needed to solicit applications for qualified EFP vessels. The RACE division will review the RFP and suggest changes as needed before it is advertised. The permit holder will also be responsible for informing the Alaska Region of National Marine Fisheries Service of field testing dates and required EFP vessel information prior to each field test.

At the completion of the EFP field testing activities, the permit holder will be responsible for data analysis and preliminary and final report drafting in consultation with Dr. Noelle Yochum of the Alaska Fishery Science Center and other RACE scientists assigned to this project. The permit holder will present results from the each field work season to the pollock industry, and the North Pacific Fishery Management Council (Council) and its advisory panels according to the direction of the Council.

Attachment 1. EFP 11-01 Final Report (electronic attachment to EFP application email)

Attachment 2: Summary of May 2017 Salmon Excluder Workshop

Detailed Summary of NPFRF's Salmon Excluder Workshop
May 9, 2017 at the Mountaineers Club Seattle

Attendance: The workshop started at 9:30 am with roughly 35 people in attendance at that point. By 10:30 am there were close to 50 in the room. Attendees were a good cross section of CP and CV sector captains and the full range of horsepower categories within the Bering Sea Pollock catcher vessel sector. Several NMFS and industry-sector researchers who have worked on field testing salmon excluders attended the workshop as well. Finally, two California commercial salmon fishermen and one Washington charter operator were there and participated in the discussion.

Workshop Findings:
During the 5 hour workshop, various perspectives were presented on what works for excluders, what does not, and how what works differs by vessel class. The most basic message was that salmon excluders are an important tool to address the salmon bycatch problem and while performance of different excluder designs differs by vessel class, everyone faces similar challenges. Examples of common issues are problems from fish becoming gilled in the excluder, problems getting lights to work as intended, problems with the current types of cameras available to evaluate excluder performance, the challenge of how to get excluders to work while maintaining target catch rates, a more-informed understanding of the parameters of nets and door/bridles that work for the economics of the Bering Sea Pollock fishery and how that affects excluder use and performance, and finally the challenge of excluder testing and improvement in the context of the regular Pollock fishery where doing things to test gear costs time and money. The workshop also illustrated that while there are some common challenges with salmon excluder for all sectors of the BS Pollock fishery, the emphasis is different for different sectors and the solutions to these problems may very well differ for different scales of vessel and door/rigging configurations.

Overall everyone who was invited to give a formal presentation and others who spoke up at the workshop thought that significant progress has been made with excluders and lights to make them more effective but additional work needs to be done to get to levels of performance in the Bering Sea such as 50% escapement. This 50% performance target likely comes from what was achieved in excluder tests in the GOA and individual tows with high escapement in APA's work in the Bering Sea. The consensus at the workshop was that better tools are needed to make the next round of improvements to excluders. Some of the tools needed for moving the ball forward that were discussed were:

- Small affordable recording cameras that work more reliably and are easier to use

- Getting real-time cameras to a place where they are more affordable and more practical, particularly for smaller boats that don't currently have the ability to affordably install a "4th wire" cable winch system.
- Availability of field testing helpers and technicians to deploy cameras on boats to help captains understand what their excluder is doing. Along with this, these technicians would provide trained eyes and the patience to summarize the video into what is important and short enough for a captain to watch.
- Improvements in sonar equipment to image the shape of the net in locations aft of the headrope and potentially all the way back to the codend.
- Lighting that is brighter with batteries that allow for long duration between charges. Also, research on colors and types of lighting to help fishermen understand potential for increasing escapement with different types and colors of light.
- Better ways to shape excluders with water flow and increased spreading of meshes (e.g. T90) with less reliance on weight and floatation
- Improvements in and more affordable types of float rope so it can be used in place of individual floats that break and lose buoyancy and tend to snag during the setting of the net.
- Arrangements to help fishermen test new ideas that allow the research to be done effectively and in a manner that does not penalize fishermen so heavily from lost time and development costs. An example here was APA's making Ed Richardson available to conduct field research and review video. Another was EFPs which provide added fishing opportunity and allowance for extra salmon outside of the regular fishery to fund the slowdowns associated with testing.

While the workshop did tend to focus on what is needed to move the ball forward on excluders, almost all speakers commented that a great deal of progress has been made since the last workshops involving all sectors of the fishery associated with the first set of NPFRF EFPs. The consistent message from this workshop was that people want to do more to get excluders to work and want to focus on what makes the most sense for their vessels and makes use of what has been done in the past. Many speakers started from the premise that a lot has been learned to guide people to selecting the best excluder for their boat and how to make it work but additional work needs to be done to make this information available to fishermen (not so much the ones that attended the workshop but the others who elected not to come or were unable to do so).

Another common thread was that while there is now considerable information available to those who want to select the best excluder design for their boat/net and add lighting to the exclude, it still remains very important to tune the excluder to the boat and net. One of the most repeated statements was that "There is no plug and play excluder" or even any formula that will reliably allow someone to just put on an excluder and get decent performance. Many speakers and attendees highlighted the need to tune the excluder to the specifics of each vessel and its trawl system. Video work is the only way to do that. Having the technical help from a video technician to get video to confirm the desired shape is being attained and verify escapement rates is an important step in making excluders work. Many stated that technicians and better equipment to make that process easier and more streamlined is a key need for achieving improvements.

The APA work on the flapper excluder has brought performance for the Pollock FTs further than where things were when NPFRF tested excluders via an EFP. Rates in the 25-35% range (for chums) are being achieved and the CP sector representatives at the workshop felt that the addition of artificial lights is mostly what has allowed for the gains in performance although other factors in excluder tuning are also important.

Regarding ideas for new directions for NPFRF to improve excluder performance, Kurt Cochran presented a rather wide set of new ideas based on things he has been able to look at in his self-guided trials. Kurt has spent an enormous amount of time and energy working on excluders and excluder concepts in the GOA Pollock and other trawl fisheries. He distilled this to six new ideas ranging from "haulway" excluders to high-spreading meshes, to scoops to improve water flow, and excluders that blend elements of flapper, over and under, and excluders used in the hake fishery. He felt all these ideas could be used in some way to improve performance in the Bering Sea.

In addition to providing perspectives on what he has learned about flapper excluder and light from his work with Ed Richardson and his camera deployments, Dave Irvine (captain of the Starbound), presented a new idea for where to focus. His thought is to use light in the front end of the net. This would be in the bigger mesh section of the net where salmon could potentially swim out without any modifications to the net. The discussion of this idea focused on how to install lights in the front part of the net without creating high risk of tangling up the front of the net and how to test the effectiveness of this given challenges for using video to see very far in the "big mesh" front portion of the net which is far bigger than any known camera can cover.

Mike Stone (catcher boat owner and former net designer) talked about his "bowtie" design can be used to get the shaping of the flapper or over and under without using the weight and floats. He came up with the design because he feels that weight and floatation can make the excluder cumbersome and susceptible to tangling during setting. Mike has put this idea into a flume tank but it has not been tried in a Pollock (went in the water for a tow or two but without a camera).

A West Coast salmon fisherman in attendance wondered if anyone had tried placing an electric current on the trawl warp, doors, or headrope/footrope based on the notion that some salmon boats with an odd electrical charge in their troll gear or the vessel itself seem to repel salmon.

Other more conventional ideas brought up at the workshop were for double or even triple O/U excluders or multiple flappers in the net, one behind the other with some spacing. These, it was stated, would best be looked at in the flume tank where RD is cheaper although there were varying opinions about the utility of the flume tank to look at ideas. This was based on concern that something that looks good in the tank might not take the exact same shape in the real world. Several who feel the tank work has been critical to excluder development pointed out that in their experience tank work has allowed them to attain the proper shape faster when the design in translated into full scale in a net. As for how fish react to excluders, advocates for the value of tank work were clear that they never expected to get information on fish behavior or reaction to the shaping of the excluder from tank work.

Overall the sharing of ideas between sectors at the workshop was significant and very productive. Feedback after the workshop was that a lot was learned about what other sectors were doing whether it was on the smallest or the largest vessels represented at the workshop. Also, the invited salmon fishermen appeared to come away a deeper appreciation and understanding of what the Pollock and hake industries are doing to reduce salmon bycatch.

Some detailed points of interest from the invited presentations at the workshop were as follows:

*John Gauvin presented the findings from the NPFRF' latest Bering Sea EFP covering 2015-2016. The goal of the EFP was to take what performed well in the GOA O/U excluder trials and test it on three vessel classes in the Bering Sea. Adjustments were made for each stage in the fieldwork to try to get closer to the shape of the excluder from the GOA trials on the F/V Caravelle. The overall results were that the Bering Sea trials never really tested what worked well in the GOA due to challenges in achieving the correct shape on larger Bering Sea vessels/nets, difference in towing speed, or other factors. The EFP resulted in a set of recommendations for tracking escapement during a tow and looking at catch rates, tow speed, and other factors when actual escapes occurred instead of looking at averages for these for the entire tow and assuming that difference during the tow did not matter. The EFP also used lights on the cameras to gauge salmon excluder performance but the effects of light on escapement rates in the context of escapement rates overall cannot be disentangled.

* Ed Richardson presented his findings from 16B and 17A 'ride along' trials using lights. He also talked about the 'Jaeger hole' in addition to the flapper. Ed's tests were done on a flapper design excluder in the straight section of the net just ahead of the codend. He talked about the pineal gland/ pineal window and how research into salmon physiology and biology with light makes him feel like light has a lot of potential. He talked about violet/ blue light being inhibitory and green/orange light being excitatory. He talked about how light color could affect salmon behavior in the nets. He said that for 17A he worked with the Northern Jaeger and Starbound and tests covered about 40 tows. He said that the limiting variable for the research is lights, and talked about the questions that still remain in using light- some of these questions may be answered by fieldwork by Noelle Yochum who has replaced Craig Rose in AFSC's RACE Division. Ed spoke a little about the scattering layer and how the biota there fouled the net, and how that affects the efficacy of the excluder, in addition to the concern with filling up the bag into the section where the excluder is located. He said that in 16B he worked with the Northern Jaeger and tried out the 'Jaeger hole' and looked at different light colors (white vs blue vs green/orange). He didn't see any differences with color. He did mention the issue of the flapper puckering. He theorized that chums were more excited by lights than Chinook, and that the 'Jaeger hole' increased escapement of small pollock. Note that he and Gauvin

put the 'stimulating' light in different places on the excluder. The NPFRF testing had the lights on the hood and scoop, whereas for Ed's work the lighting was at the top of the flapper ramp beaming back into the excluder.

* Kurt Cochran provided extensive background on the excluders he has used, including a Foulweather design with escape out the sides (Lomeli); the Swan flapper; the Green Line excluder; and the Over/Under. He also mentioned the puckering issues, and said that the Over/Under was most adaptable, worked the best for smaller boats. He talked about a new design- the Turbo tube- made by LFS- it is a cone shape design that works with the change in water flow. Time did not allow him to get into a lot of detail on many of the technical details. He mentioned that lights can attract SSLs. He uses the L-P lights, and said the more that are used, the better. He has not tried different light colors to see whether that affects escapement.

* Dan Martin talked about his experience with excluders in the BS EFP and on his own. He uses an Over/Under in the last tapered section of the net. He talked about using T90 and how it holds the bag open, but it increases the strain. In the hoods, the T90 made the hood stand up 8-9 feet and in the bottom the hood kept its shape without weights. He talked about going away from plastic floats in favor of float rope for more uniform lift and to avoid snags that occur when individual trawl floats get hung up in the meshes. He said there is a lot more to discover/ many issues to solve, but the issue is the cost of R&D.

* Jamie Buskirk talked about excluder designs he has used and all the EFP testing he has been involved in on the Pacific Prince and Destination. He is currently using the Over/ Under. He talked about how we need to figure out the right combo of net, door size, flapper design, and tow speed to get at the problem of salmon bycatch.

* Dave Irvine has been working with Ed Richardson to test the lights with the flapper excluder in the straight section, the last section before the codend. Length of the straight section is important for excluder performance and to avoid loss of Pollock. He remarked on the need to get people to watch some of the video collected and the need to have someone with technical ability watch it and reduce it to something a captain has time to watch. He talked about how escapement is reduced when the gear gets wobbly. 32% escape is the best he has seen. He is using the Swan flapper and likes the ease of it. He, like Ed, was using the Westmar light, but feels that it is not enough. The more light the better.

* Tim Thomas talked about how bad weather affects pollock loss when using the excluder. He acknowledged the fear of losing out on pollock when using excluders, and how each vessel is different in this regard but really Pollock loss has not been anything big enough to worry about for quite a while. He said that, overall, of importance is the opening in the escape area in terms of size and that the materials need to be pretty still to avoid spooking salmon and they move up to the opening. He remarked that in his experience, Chinook are not as aggressive as chum, and are less willing to go out. He is using the JT Electric LED light (green) like Ed has used. He remarked that light is important. He talked about how the marine layer really affects the dynamics of the

excluder (plugs it) when fishing deep. He also said that the excluder can affect the how the catch indicator devices work.

* Mike Stone talked about how the gear is shaped and how this can be controlled with changes in speed. He talked about a new “butterfly” excluder design that he plans to try. It has four openings (hoods) in the top and bottom- like the Over and Under x4, but it uses tapering and adding meshes to achieve the shape instead of floatation and lead-core line (weighting). The design ends up looking like it would look if you looked down the barrel of a double-barrel shotgun. A potential downside he can see is that fish can come out of the scoops on deck depending on the length of the extension.

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